A Model for an Effective Learning Process in Higher Education: An Example from Three use Cases

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Abstract: Knowledge is the most important asset in education. Knowledge Management has been the focus for many years in higher education. Recently, universities have embraced innovative processes that could foster a better learning process. Digital learning platforms such as Canvas or Blackboard has been deployed at the higher education to facilitate the learning process. However, it is still recognized that knowledge might not be fully acquired by students. Adoption of technological artifacts has proven to be a good step forward; however, it seems not sufficient. Lately there has been a focus on how to implement student centric methodologies to foster learning effectiveness. For instance, Project-based learning (Trullàs, Blay, Sarri, & Pujol) approach intends to provide to students the possibility to be engaged in project reflecting similar issues such in real life in order to further develop skills and competences. This paper outlines two approaches based on the leitmotiv "learning by doing" and on the implication of students in defining jointly a use case for their home exams. The paper presents 3 experiences from 3 universities based in Norway and Spain. A model for an effective learning in Higher Education is delineated.

Keywords: relevance of higher education, experiential learning, case-based learning, project-based learning, student active learning

1. Introduction

Academia is no longer an "ivory tower" (Etzkowitz & Leydesdorff, 2000), but instead, an organic part of a system to support the development of innovation, entrepreneurship and sustainability in an ever-developing knowledge-based society and work-life. It is well recognized that education and life-long learning are essential for the well-being of the society and goes beyond schools and universities. Academia should adapt their traditional way of teaching since education is considered to be a pillar of a knowledge economy. In addition, Academia should not only address the requirements of students represented as the Y or even the Z generation but as well should consider the lifelong learning trends. Companies or Individuals recognise the importance of developing new skills or competence during the work-life that could be relevant to their profession or their daily work activities.

Therefore, traditional education systems need to cope with the above listed challenges and new ways of knowledge creation or acquisition are fostering new approaches so that the learning processes are taking place in an effective manner. Several universities are promoting the leitmotiv "learning by doing" leading to two paradigms Project-Based Learning (PBL) and Problem Based Learning (PrBL). Larmer have identified some similarities and differences (Larmer, 2014). For example, PBL uses often uses cases or fictitious scenario while PrBL uses real world authentic cases.

Project-Based Learning (PBL), as a teaching methodology, is widely adopted by several secondary and higher education institutions (N. Krajcik, 2014). Aalborg University (Bertel, 2021) is pioneers in being totally oriented to PBL, based on the claim that project-based education is multidisciplinary by nature, and thus allows better results due to the active involvement of the student. Since Kolb presented his model of experiential learning (DA Kolb, 1984), a growing interest in implementing PBL as a new approach for teaching and learning has emerged (Baker, Robinson, & Kolb, 2012; Guo, Saab, Post, & Admiraal, 2020; Nurhidayah, Wibowo, & Astra, 2021). PBL approach has been recognised as an effective learning method since it requires an active participation of the students within the learning process (Terrón-López et al., 2017). In addition, students might share their acquired knowledge with other students while enhancing their learning experience by fulfilling their learning objectives.

Problem based learning (PrBL) methodologies have been successfully used in different domains. An active, collaborative and project-based learning methodology in the domain of software engineering is described in (Exposito, 2014), while PBL has been demonstrated an effective and satisfactory methodology for medical education (Trullàs et al., 2022).

Several methods to develop a PrBL models have been outlined. For instance (Phungsuk, Viriyavejakul, & Ratanaolarn, 2017) have developed of a Problem-Based Learning model using a virtual learning environment (VLE) for undergraduate students in the Photography for Communication Arts course. A web-based PBL application integrating PrBL authoring tool, a PrBL script instantiation tool, and a PrBL-specific run-time environment is developed by (Wang, Samaka, Miao, Ali, & Hoppe, 2016). PrBL also appears as a learning method for agile models of Software Engineering (Monett, 2013), robotics subjects (López-Nicolás, Romeo, & Guerrero, 2009), as well as for non-technical subjects such as marketing (Dušek, 2021).

However, although there are clear benefits, PrBL is not exempt from difficulties when it comes to bringing it to reality in the class-room (Park Rogers, Cross Francis, Gresalfi, Trauth, & Buck, 2011).

The main question is how to ensure students engagement in their learning process?

The Inland Norway University of Applied Sciences is investigating if involving student in the definition of homework exam based on use case of their own organisation would improve their grade. This approach is dealing mostly with students that are working in company and are undergoing into professional education. Utilizing the students' own initiative and background to develop these use cases may support the experience of relevance when working on the exams. The sense of relevance motivates for the learning to stick for then to become knowledge the students can use in a work situation.

This paper aims to look into the future of education by considering these different approaches in facilitating an effective learning process. Project based learning approach have been used at University of South-eastern Norway (USN) and at Universidad Europea de Madrid, Spain (UEM) while engaging students in defining their own homework exam based on their working environment has been implemented at USN and the Inland Norway University of Applied Sciences (INN). Our research is based on analysis of the teaching and learning approaches as described above to delineate a general framework encompassing some factors that will contribute to foster a learning process effectiveness.

The data are collected from three different courses; one course in "systems engineering" that is held at USN and one course in "learning organizations" that is deliver at INN. In addition, data collected at UEM are within the degree in computer Engineering as the PBL is a cross disciplinary and involved several courses.

The second section describes the cases of the three universities and outline some output of the evaluation of the implementation of project-based Learning and the student's engagement in homework specification.

The section three presents a preliminary framework of the ongoing research study.

2. Project based Learning and students' engagements in homework specification

For the purpose of our research, we adopted a case study approach as it is a suitable method for verifying and comparing outcomes across similar cases (Widdowson, 2011). This approach is generating an in-depth, multi-faceted understanding of a complex issue in its real-life context (Crowe et al., 2011). Stake defines "A case study is both the process of learning about the case and the product of our learning" (Stake, 1995). A case study is qualitative research and will contribute to gather data for providing a model encompassing factors that identified in using Project-Based learning and active students' engagements for an effective learning process.

The paper describes a multiple case study of the three universities' cases. To optimize predictive efficacy of the data collected, we used a mixed-mode approach for obtaining insights from the surveyed organizations. Literature reviews were exploited to add additional dimensions to our study.

2.1 A Project-Based Learning at the University of South Eastern Norway

2.1.1 Background of the case 1

From 2014 until 2020, a course systems engineering was conducted for master students for two different programs. One program was for student working part time and taking a master's degree within the field of systems engineering and the second program was for full time students in Master of embedded systems. The course was run over five full days. The course of "foundation of systems engineering" intends to provide a systematic approach to build a system starting from business needs or opportunity to system phase out. The part time students are all working in a company that is part of the joint educational program with USN. The two batch of students have to deliver homework 6 weeks after the lecture. The full-time student, in addition to the homework, must deliver a physical prototype or artefact based on the method of systems engineering.
The next sub-section describes the project-based learning projects and the HomeWorks.

2.1.2 Project Based Learning (PBL)

The project underlying background of the PBL was to learn how to apply with a concrete project the foundations of systems engineering. The project duration was set for five months. The group of 4 or 5 students should suggest a topic addressing a need, design and develop a prototype of the solution.

Over 7 years, there was several types of projects such as Snowplow robot, robot to remove plastic in water, automatic food pet delivery, automatic garbage sorting, etc... All the projects were built by the student under the supervision of a teacher, experts in some cases. They usually meet once a week for reporting the project progress. The students had to elaborate a budget covering the physical parts of the solution and USN provided the funds to buy the necessary device or equipment in case it was not available. The budget was small and thus students should come with a solution that was cheap but addressing the needs that was formulated at the beginning of the project. During the 5 months of the projects, that was divided in different steps such as stakeholder and their requirements identification, translation of these requirements into systems design, prototype building and verification of the solution. At each phase, students should make a presentation front of their other students so that everyone was aware of the progress of each group.

2.1.3 Use case from student's own organization

The homework encompasses one general part that was mandatory and two use cases to choose from. One general use case was specified by the teacher with several questions to answers, while the second one student could use rather their own organization as use case and answer the same questions.

Also, throughout the semester, the students have co-developed cases with the teacher and solved them in a plenary session. The mandatory assignments were to be solved in groups. By "forcing" the students to relate the curriculum to either their own or fellow student's workplaces, they were able to understand the different theoretical issues, also from a practical implications' perspective. The feedback was provided by either the teacher in the course, or a professor with similar competence from another institution. Exams were executed in the same manner; with two options and similar questions. The evaluations show that the students appreciate this approach and that they find the courses relevant for their work-situation.

2.1.4 Process evaluation description

The start of the initiative the use the PBL as a mean to expose the students to real life problem by developing prototype was not a smooth process as instructors did not have experience in this approach. Several challenges and issues for both instructors and students were identified and were addressed the following year. In order to assess this teaching/learning approach a mixed approach was conducted. A short survey sent to the students and informal meetings or interviews with both instructors and students were conducted over 6 years. Data collected and the analysis of the final solutions developed, showed that there is clearly an improvement, not only in the process itself, but as well in the result of the prototype and the report quality. This approach showed clear benefits for students in acquiring and applying knowledge of the systems engineering concepts and in others skill such as ability to work in team, to communicate, to cope with conflict resolutions, to manage project, to solve problem in creative manner and so forth. However, advantages for the instructors were not obvious as it required more time and willingness to investigate new domain of applications as the students were the one providing topics for the projects. We have identified few positive feedbacks from instructors related to the enjoyability of developing a concrete project, continuous challenges in getting new ideas or contributions in some cases in their research activities. For the organization, promoting such BPL is a means to attract more

students and to be defined as university of the future, though challenges for universities and instructors needed to be overcome. For instance, adaptation of the curriculum, schedule, lack of experience, resource demands, lack of consistent support, lack of incentive, costs for education, lack of instructors willing to embrace the PBL, lack of industrial experience of the teacher, a number of aspects that lead to more theoretical project.

Student's engagement in homework were assessed through analysis of whether students would choose the use their company as use case results and the evaluation of the homework results. Comparisons of the results showed a better quality of the homework when students would decide to write their own case study. The experience showed that students had better engagement with their coworkers, developed a better understanding and had to adopt a better reflective practice. Informal interviews with the students indicate that although they spend more time in describing their own case, they found it more relevant and thus more interesting to work on the homework.

2.2 A project Based learning at Universidad Europea de Madrid (UEM)

2.2.1 Background of the case 2

In 2012, Universidad Europea de Madrid opted for Project-Based Learning (PBL) as a keystone of the way their students should learn. The idea was to adopt a common approach across subjects in order to develop students' knowledge and skills, allowing them to become competent professionals who are capable of meeting educational and social needs. The leitmotiv was "students learn best when they apply knowledge as a part of real-life projects", just like they will do in the professional world.

As a part of this learning model, students begin working on projects in their first year. As a result, they develop communication, collaboration, problem-solving, and critical-analysis skills. Moreover, this learning methodology even occasionally includes collaboration with different companies and/or institutions, letting them to go closer to industry.

The study plan of the Computer Engineering Degree encompasses a specific teaching module dedicated to PBL including student's knowledge acquired in the basic training module.

The PBL approach was designed as well to include other modules taught in the same semester. The projects undertaken by the students were ranging from robot development to Data Analysis or Artificial Intelligence artifacts.

After three years of wide-spread implementation of this model in all engineering degrees and after carrying out an initial analysis of the results, in September 2015 the study plan of the Degree in Computer Engineering was modified, among others, to include specific courses on development of projects in all the years of the degree. Experience gained through PBL implementation highlighted recognized benefits not only for students, but as well for instructors and the University as indicated in the case 1.

2.2.2 Process evaluation description

A decade after the implementation of the PBL methodology, a self-assessment was conducted to investigate further the success criterions and to provide support for teachers that were engaged.

Measurement of impact was done through quantitative method. Data related to thirteen subjects of the Degree in Computer Engineering using either PBL or more traditional methodology have been analyzed to see the influence of PBL. These data include, over time, the evolution in the percentage of marks the success rates and the satisfaction of these subjects after the two runs for each course. The analysis has covered from the academic year 10-11, in which there were still no specific project subjects, up to the academic year 20-21.

Assessment shows that average percentage of students passing in traditional subjects has been gradually rising from 65% 2012 to 80% in 2018 as a collateral effect of the new project-based courses. The percentage dropped slightly the last couple year 2020 and 2021 probably due to the COVID-19 pandemic. Although there is a growing number of students passing their courses since year 2012 till 2018, analyzed of the data from year to year, showed that the grow is not linear. It shows that the type of project could influence the learning outcomes and the acquired knowledge.

Due to the success of PBL, the university have decided to expand this approach and thus have adopted a more systematic way to PBL implementation. A Project Based School (PBS) Office was created to support professors and provide resource to implement PBL in their classrooms at three levels: single course, integrative projects (IPs) covering more than one course and an extracurricular level with projects developed within students' clubs, external contests or other similar activities.

2.3 Engagement of student at homework process in the Inland Norway University of Applied Sciences

2.3.1 Background of the case 3

The courses that are a part of the research area are "Learning Organizations" and "Knowledge Management", both courses of 7.5 ECTS. The curriculum has previously been presented as lectures during seminars (1 day 3 times per semester). These were long days for both students and lecturer and thus it was decided to test out the Flipped Classroom (REF). Videos were then made available in the Learning Management System (LMS) and then only short lectures were provided during the seminars, introducing cases. A separate case book was developed for this purpose, which worked very well. In 2017 one of the students were the responsible for developing onboarding and training for newcomers in his organization and he asked to use his organization as a case for his assignment. The following semester, this opportunity was presented to all the students, but with an option of an "ordinary" case. Co-development and co-design became very popular in other courses as a part of the curriculum (for example within service design) and the idea of invite the students to co-design the assignments emerged. This development has become a very welcomed way of working together with the students and according to the student evaluations, this has contributed to the relevance of the courses back in their organization.

2.3.2 Process evaluation description

There have been several rounds of evaluation processes, both as a part of the quality system at the University, but also as a part of the research on relevance of higher education back in work-life. Through net-based surveys, interviews with individuals and groups, a careful evaluation of all the singular steps in the development from lecture-based education to Flipped Classroom combined with co-creation of assignments, has been carried out. The recruitment to the study program is rather stable and there is a waiting list to enter amongst the approximately 100 admitted each year.

3. Findings and discussion

Based on analysis of the three cases, we have identified few elements or factors that could play a significant role in ensuring an effective learning process for PBL and self involvement.

They are summarized in the following picture:

There are several factors that could be all explained. However, we can list some of them such as:

Intrinsic and extrinsic motive was important for both students and teachers as discussed in (Chiang & Lee, 2016).

Usefulness/Engagement is as much important for the teachers and students. The Gallup's Student Poll analysis clearly stated that students achievement is directly linked to its engagement (Reckmeyer, 2019).

Fairness/recognition by the organisation is essential for teacher as this new way of teaching require times, stronger and frequent interaction with others academic staff or students. Therefore, their effort to launch this type of initiative should be recognised by the university by providing technical and financial support. Instructors getting recognition for their academic work are motivated to pursue high-level instruction (Andrews, 2011).

Leadership has proven to be a very important factor. The work of (Carmeli et al., 2011) highlights the importance of leadership for promoting relational and organizational identification, thereby facilitating a positive environment for fostering innovative approaches for teaching.

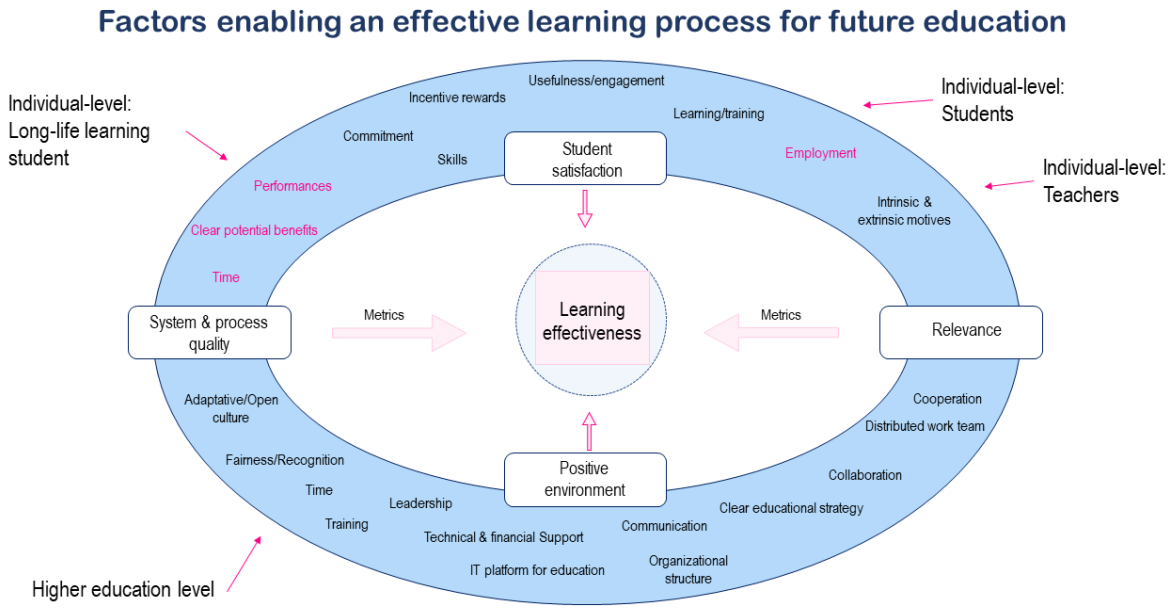

Figure 1: Factors for enabling an effective learning process based on PBL and student's engagement

4. Conclusion

This paper investigated the factors that could plays an important role in fostering learning process while using project-based learning as an educational methods and engaging students that are working in specifying their own homework based on their companies. The paper report experiments conducted in three different universities over several years and the aggregated results of assessment lead to a specification of a model encompassing several factors to be considered for good learning process. The work is still ongoing and cross comparison between the approaches needed to be further evaluated. However, the results of the assessments outline that although there are clear benefits that are more numerous for the students than for the instructors or higher education organizations; there is still a need to cope with challenges such as dedication, time, costs, curriculum adaptation, incentive, technical and financial support, etc. This is more relevant for Project based learning process. Engagement of the students in the specification of their own exam proved to be a good approach in fostering better quality. Academic and teachers have a strong role in fostering the knowledge sticking for the students and therefore adequate infrastructure supporting in an effective way the process should be well designed by the higher education organizations.

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